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GRAPE
PROPAGATION
PRUNING and TRAINING



GRAPEVINES may be propagated by means of seedlings, cuttings, layers, or grafts, but seedlings are good only for originating new varieties, and the young plants are seldom used even for grafting stock; so, practically, there are available only three methods, each of which will bring vines true to name. This bulletin describes all three methods.

The principles, methods, and objects of pruning both the young and the bearing vines in winter and in summer are presented.

The training systems followed in the principal grape regions are varied by the different natures and habits of different species of grapes. These systems are elaborated and illustrated in this bulletin in such a way that they may be intelligently selected and applied to various cases, from the growing of a few vines on a city lot to the care of an extensive vineyard.

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GRAPE PROPAGATION, PRUNING, AND TRAINING

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IMPORTANCE OF GRAPE CULTURE

BY NATURE the grapevine is a great rambler. Some forms are found in the woods striving to overtop the tallest trees, and single plants overspread large areas. Other forms are grown as mere bushes, 2 to 3 feet high, producing crops ranging from $1\frac{1}{2}$ to 22 tons of fruit to the acre. No other fruit-bearing plant responds so generously to attention, adjusts itself to so many conditions, or is used for such a variety of purposes. For these reasons its culture has always kept pace with civilization.

Native species of the grape are found in nearly all parts of the world, and no country has a greater number of them than the United States. It is therefore reasonable to conclude that grapes can be successfully grown almost everywhere in this country, with results depending largely upon selecting varieties of the species suited to the respective conditions. (Fig. 1.)

FIGURE 1.—An experimental vineyard of the Bureau of Plant Industry



PROPAGATION OF THE GRAPE

SEEDLINGS

In ordinary practice grapevines are propagated from seed, from cuttings, by layering, or by grafting. For originating new varieties, seedlings must of course be used. The individual seedlings differ

so widely that they should not be used by the intelligent planter even for grafting stock.

CUTTINGS

Cuttings for propagation may be prepared at any time after the vines have become dormant. Other things being equal, and if they



FIGURE 2.—A bundle of grape cuttings

are afterwards well cared for, the sooner they are prepared after the vines have become dormant the better. The length of the cuttings may range from 8 to 20 inches, depending on the climatic and other conditions of the locality in which they are to be planted. Usually, the hotter and drier the climate the longer the cuttings will need to be. They should always be made from young, well-matured wood, and preferably from medium-sized, short-jointed wood.

To make cuttings, cut close below the lower bud, making the cut somewhat slanting (fig. 2), and leave about an inch of wood above the upper bud or eye. If a small piece of the old wood or a whorl of buds can be left to form the butt end of the cutting, so much the better. The cuttings should be tied in convenient-sized bundles, the butts being turned the same way. The bundles should then be heeled in or buried in trenches, butt ends up, and well covered with 3 to 6 inches of soil. (Fig. 3.) Inverting the bundles causes the butts to callus while the tops remain dormant, and the cuttings are ready to throw out rootlets as soon as planted; whereas, if the bundles are heeled in with the tops up the latter often start to grow before the roots to support them begin growth.

In the spring, when the ground has become warm enough, plant the cuttings in soil made mellow by plowing and cultivating. The planting may be done in slanting trenches, 3 to 4 feet apart, which can be made with a plow. Deepen the trenches with a spade if necessary. Set the cuttings at such depth that only the upper buds will project above the ground, and firm the soil well around them. The cuttings may be spaced 2 to 3 inches apart, the distance between them differing with the varieties, some of which root more readily than others. Keep the soil clean with hoe and cultivator, and stir often during the summer to keep it mellow and moist. In many localities frequent stirring is better than irrigation.

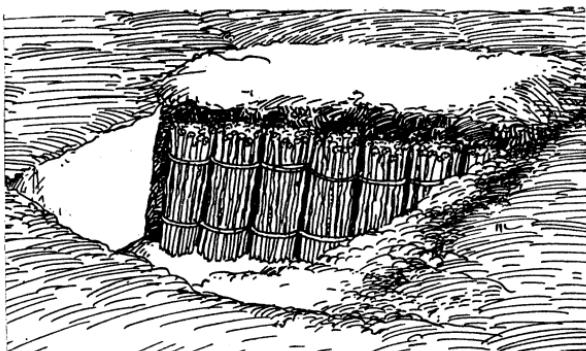


FIGURE 3.—Heeling in cuttings to keep and callus them

LAYERS

All varieties of the vine may be propagated by layers. The rotundifolia vines are nearly always propagated in this manner, but with other species layering is usually resorted to only with varieties which do not root readily from cuttings. In layering choose canes of the last season's growth, preferably those that start near the base of the vine. (Fig. 4.)

It is well, the summer before, to leave some shoots on the vine for this purpose. They should be shoots starting close above ground and should be allowed to grow as long as possible. In pruning these canes all the well-developed buds are left. The ground is made mellow, a trench about 3 inches deep is drawn from the vine with the hoe, and the cane is bent down and fastened into it. Usually each bud on the cane will produce a shoot, which by this process is made to grow upward. When these shoots are well started the trench should be filled with soil. Each shoot then takes root at its base. To assist the roots in starting, a slight incision should be made in the cane opposite each bud. The plants are taken up in the fall or winter and divided by severing the original cane behind each shoot, which, having its own system of roots, becomes a new vine. (Fig. 4.) Canes may be layered either in the fall or in the spring.

REPLACING MISSING VINES

A full stand of vigorous, even-sized vines is essential to the economical, maximum production of the vineyard. During the first few years in the life of a vineyard missing vines can be replaced by careful replanting, but this becomes more difficult each year. It is usually possible to avoid vacancies by replacing the missing vines by layering. Figure 5 shows how this may be done. The only care needed by these layers during the growing season is to prevent any growth on the layered cane, excepting the single shoot reserved for a new vine, and to tie up this cane carefully to give it the desired shape. No buds should be allowed to grow on the cane between the nurse vine and the ground. After the second year's growth the layer is cut off from the nurse vine at the point shown by the arrow. It should not be allowed to bear the first year, and only to a limited extent the second year; this restriction enables it to devote all its energies to the growth of stem and root, after which it will be ready to bear full crops.

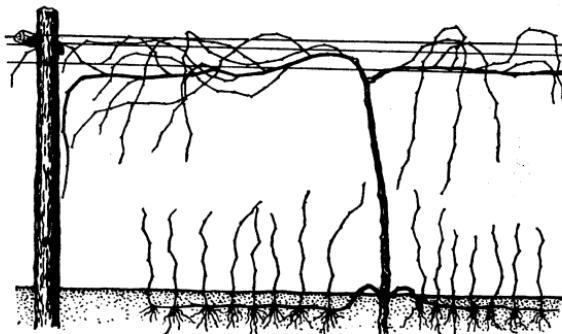


FIGURE 4.—A vine with two canes layered, showing the method of propagation by layers

a vineyard missing vines can be replaced by careful replanting, but this becomes more difficult each year. It is usually possible to avoid vacancies by replacing the missing vines by layering. Figure 5 shows how this may be done. The only care needed by these layers during the growing season is to prevent any growth on the layered cane, excepting the single shoot reserved for a new vine, and to tie up this cane carefully to give it the desired shape. No buds should be allowed to grow on the cane between the nurse vine and the ground. After the second year's growth the layer is cut off from the nurse vine at the point shown by the arrow. It should not be allowed to bear the first year, and only to a limited extent the second year; this restriction enables it to devote all its energies to the growth of stem and root, after which it will be ready to bear full crops.

GRAFTING

There are many so-called methods of grafting. Bench, nursery, and vineyard grafting are resorted to in general vineyard practice. The mechanical operations performed are similar and the under-

lying principles are the same, the essential difference being, as the names imply, the place and time of doing the work.

Bench grafting is done on benches or tables, usually indoors during winter. Cuttings of resistant varieties that root easily, or good, young, rooted plants are usually bench grafted.

Grafting vines growing in the nursery is called nursery grafting. This form of propagation is usually resorted to with varieties resistant to phylloxera that do not grow readily from cuttings. Rooted cuttings of other varieties are grafted in the nursery, and the resulting vines are planted in the vineyard.

In vineyard grafting the vines are grafted while growing where they are to remain.

Some important practical advantages of grafting are: Changing of worthless vines into valuable ones; insuring of nonresistant vari-

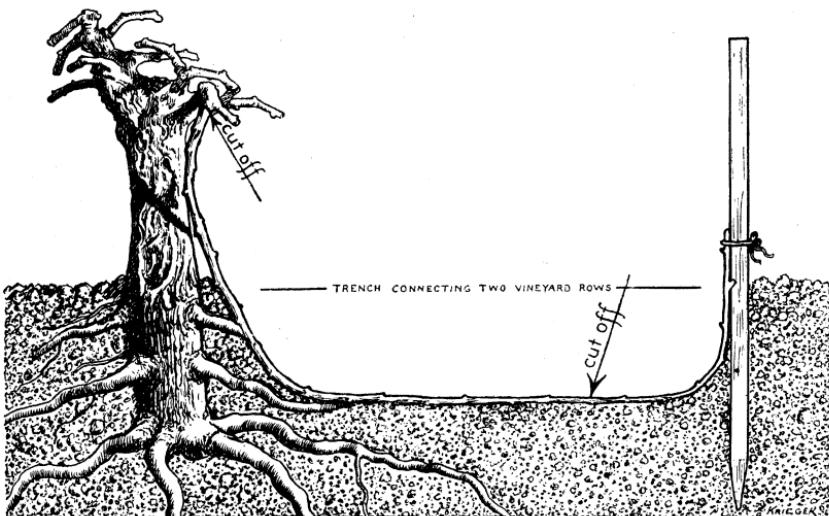


FIGURE 5.—Replacing missing vines by layering

eties against phylloxera by grafting them on resistant stocks; plenty of wood quickly obtained for propagating purposes by grafting new or scarce varieties on strong vines; and production of resistant vineyards by grafting valuable resists or direct producers on roots of growing vines and then allowing the scions to make roots of their own.

The selection and proper keeping of the scions for grafting are very important. Medium-sized, short-jointed, firm, well-ripened wood should be selected. Do not allow the scions to dry out, but keep them dormant until used by completely covering them with fairly dry sand in a cool, dry cellar. Scions may be taken from the vines at any time in winter, but the sooner they are obtained after the vines are dormant the better.

In all grafting the inner bark of the scion and that of the stock must be joined. This bark is thicker on large sections of vine than on small ones, therefore usually thicker on the stock than on the scion.

This union of the inner bark, especially in vineyard grafting, must be accurately made when the scions are inserted. In bench grafting, selecting stocks and scions of the same diameter makes possible such perfect grafting that the inner barks join at almost every point, and their union is made easy and complete. (Fig. 6.)

In bench grafting the visible and adventitious buds are cut from the stocks in order to prevent, so far as possible, the sprouting of suckers from the stalks after they have been planted.

In vineyard grafting many operators cut off the stem of the vine an inch or two above where it is to be grafted, a month or so before the grafting. This causes the stock to bleed profusely in advance of grafting and eliminates to a great extent excessive sap flow after the scion is in place.

In cleft grafting, unless it is desired to have the grafts establish themselves on their own roots, the vines are cut off at a smooth place near and preferably a little above the surface of the ground. This makes it easier to remove water sprouts and roots starting from the scion and lessens the danger of injuring the scion before it is thoroughly knitted to the stock. (Fig. 7.)

For bench grafting, a smooth surface above a node on the stock is selected. The node keeps the stock from splitting below it during the grafting. After cutting off the stock, whether a vine or a cutting, split it longitudinally with a sharp knife or shears; use a chisel if the stock is a heavy vine. Shears can be used for both the horizontal and longitudinal cuts on cleft-grafting stocks not more than an inch in diameter. (Fig. 7.) To prevent bruising the bark in making the cut, keep the blade of the shears on the side on which the scion

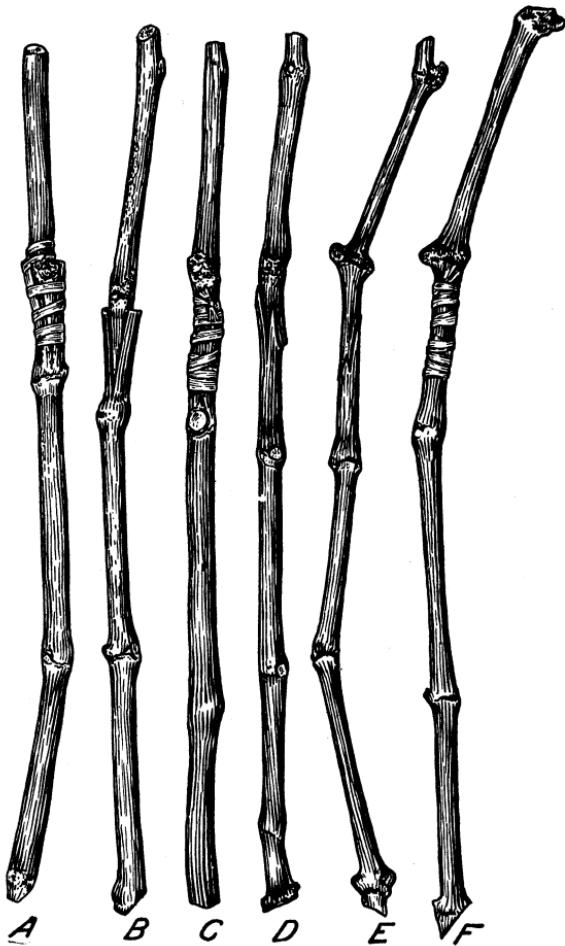


FIGURE 6.—Bench-grafted cuttings of grapevines, showing three methods of grafting: A, C, F, Grafts tied with raffia; B, bench cleft graft; D, bench whip graft; E, English cleft, split, or whip graft

is to be inserted. In preparing the scion cut a simple wedge, beginning at or slightly below a bud and making, from each side, a long, sloping cut toward the middle. Use a sharp knife. Scions having two eyes are preferable. To insert the scion, open the cleft and push the scion in firmly until the bud is just above the upper end of the stock, taking care that the inner barks of stock and scion fit closely. In grafting large vines a metal wedge may be required to open the cleft. Two scions, one on each side, are frequently used in large vines.

The English cleft, split, or whip graft (fig. 6, E) is often favored in grafting small stocks, especially in bench grafting when the diameter of the stock is the same or very little greater than that of the scion. In this method a sloping transverse cut is made upward on the stock, which is then split downward from the middle of the

cut. A like split and cut are made in the scion, but are reversed. Then the upper wedge made in the scion is pushed into the split of the stock in such a way that the inner barks join and fit closely.

When grafting is done near the ground on stocks strong enough to hold the scions firmly, no tying is necessary; otherwise the stock and scion should be tied together with rubber strips or raffia, as shown in Figure 6, A, C, and F.

In either case a stake should be driven at the side of the graft to protect it and to provide a support for the young shoots. It is good practice to press a little moist soil over the cut around the junction

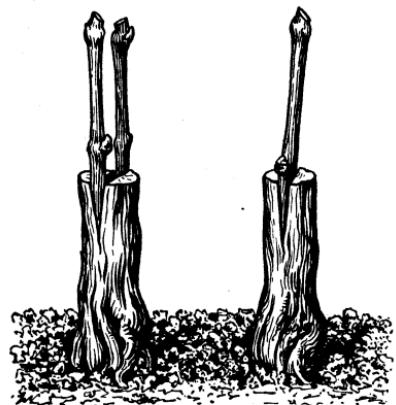
FIGURE 7.—Vines grafted according to the cleft-graft method: At the left with two scions; at the right with one scion

of the graft, and the scion must be completely covered with fine dirt to protect it from drying out.

The grafts should be examined frequently and the suckers removed, and the roots starting from scions that have been grafted on resistant stocks should be cut off.

Bench grafts are also tied with rubber strips or raffia. (Fig. 6.) They may be planted out immediately, but are usually stored or heeled in in damp, not wet, river sand, moss, or other suitable material, to allow them to callus before planting.

In summer bud grafting (done shortly after the buds of that season are developed) the bud, together with a fair-sized fragment (fig. 8) of an already woody shoot of the current year's growth, is used as the scion and is snugly fitted into a place cut out of the vine on which it is to grow, about 2 to 4 inches above the ground. It is then bound with raffia or rubber strips to hold it in place. In fitting the bud into place care must be taken that the cambium layers of stock and scion correspond as accurately as possible and, when tying the bud, that the raffia or rubber strip is first passed once around above the bud and then several times around below it, so as to insure



thorough contact at the base of the graft. Soil is then heaped up around the graft into a mound usually about a foot high, to protect it from changes of temperature and from drying. The stock is not cut off above the graft but continues its growth; the flow of sap which is thus maintained enables the union to take place under the most favorable conditions, the graft knitting while the bud remains dormant until the following spring. If not already broken down by the natural cultural operations, the mounds about the grafts should be removed at the end of the winter to determine on what vines the inserted buds have succeeded and are large and healthy and firmly united to the stocks by the callus which has formed. The stocks are now cut off from these grafts, leaving a stub or butt of 5 or 6 inches of the old stock above the bud to be finally removed a year later. The scion buds that failed, now considerably shriveled, can easily be rubbed out with the finger, and the stock can be cut off and regrafted as in ordinary vineyard grafting.

The summer bud graft is especially suited for field grafting 1 or 2 year old vineyards. One man can easily do from 350 to 400 a day.

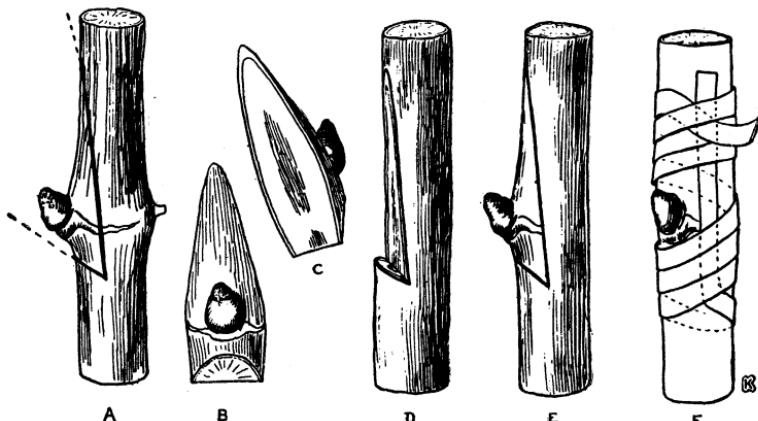


FIGURE 8.—Summer bud grafting: A, Cutting bud out of an already woody shoot of the current year's growth; B and C, two views of bud ready for grafting; D, place cut in stock for it; E, bud grafted in stock; F, bud grafted and tied

Practically perfect stands are obtained when the grafting is done by skilled men, with unions far surpassing those obtained by ordinary grafting methods.

Some of the advantages of summer bud grafting are: Better unions; better and longer lived vines at less expense; grafting done when there is little else to do in the vineyard; the few stocks on which buds fail are available for grafting in the ordinary way the spring following; and a full year's time gained in establishing vineyards on resistant stock.

Excellent results have also been obtained by bud grafting cuttings of easy-rooting, phylloxera-resistant stocks or rooted vines the same year they are set in the nursery, also by using dormant buds and bench bud grafting rooted vines or cuttings of sufficient caliber and then placing them in the nursery.

SOIL AND LOCATION

The most suitable soil and location for a vineyard, the preparation of the soil, the laying out of the vineyard, the cost per acre of establishing it, and the cultivation and fertilization necessary in obtaining the best results are not discussed here, as they differ decidedly under differing conditions of soil, climate, etc., and need to be dealt with in a special treatise.

DESCRIPTION OF THE PARTS OF A VINE

An accurate knowledge of the names of the different parts of a vine is necessary before the subject of grape training is considered. Figure 9 illustrates a vine, the different parts of which are designated by letters.

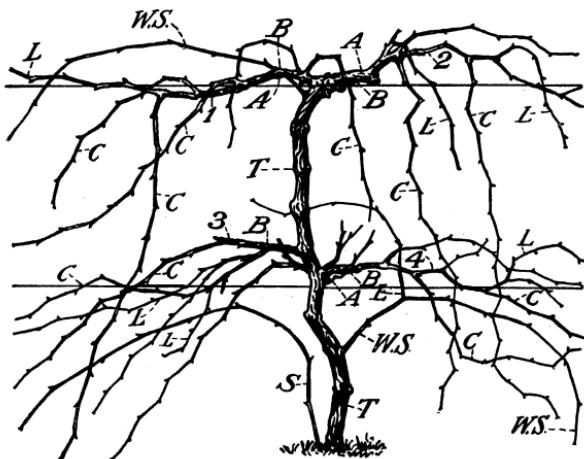


FIGURE 9.—Diagram of a grapevine, showing the different parts and illustrating the 4-cane system of training: A, Arms or ramifications of the branches, usually of wood 2 or more years old; B, branches which are of mature wood, being several years old; C, canes, called shoots when green and canes when mature; L, laterals, the secondary shoots of a cane; S, suckers, the shoots starting below the ground from the main body; T, trunk, the stem or main body of the vine; W.S., water sprouts, the shoots which start above the ground from wood older than 1 year; 1, 2, 3, 4, 2-year-old arms

produce sterile canes only when too few eyes are left in pruning or when the eyes have been destroyed. At the base of each eye on a cane there are two dormant buds. Sometimes one of these grows the season it is formed, making a lateral from which secondary laterals also may grow. These first and second laterals bear the so-called second and third blooms of grapes.

CARE AND TRAINING

The treatment given vines during the early years of their growth largely determines the profit and pleasure to be derived from them. If they are improperly cared for during this period they will not yield satisfactory returns afterwards.

PLANTING CUTTINGS OR ROOTED VINES

If cuttings (fig. 2) are planted and the supply is sufficient, two in each place increase the chances of getting a full stand. Should

The basal eye or bud, which is not reckoned in counting the eyes on a spur, is near the base of the cane. When more than four eyes of a cane are left in pruning, it is generally called a fruiting cane.

Water sprouts and suckers do not ordinarily produce bearing shoots.

Below the basal bud on each cane are one or more dormant buds, which grow and

both cuttings grow, one can easily be pulled up without injuring the other. To protect the cuttings from drying out, plant them so that the top bud projects only a trifle above the ground.

If rooted vines, either plain or grafted, are used, the roots should be cut back to 3 to 4 inches, depending on their vigor. Only one cane of the top should be left, and this should be cut back to two or three good buds. (Fig. 10.) If grafts are used, all scion roots and all suckers should be carefully removed.

Usually no pruning or training is given during the first year after planting, although it is, perhaps, a good plan with vigorous plants, especially if the season is propitious, to rub off all except the straightest and strongest of the young shoots that start. (Fig. 11.) The following winter the vines should be pruned and staked before they start to grow, the size of the stake used depending on the method of training adopted. In ordinary stool or spur pruning, or where the vines are to be trellised or arbored afterwards, a stake $1\frac{1}{2}$ to 2 inches square should be used, long enough so that after being driven $1\frac{1}{2}$ feet into the ground it will reach 1 or 2 inches above where the vine is to be headed. If the vines are to be pruned to canes and the latter tied to stakes, it will be necessary to use stakes 2 inches square and 5 to 6 feet long. (Fig. 12.) When *rotundifolia* varieties are to be grown on overhead arbors, posts projecting about 7 feet above the ground should be planted beside each vine, opposite the prevailing wind. (Fig. 13.)

FIGURE 10.—A grapevine showing the method of pruning roots ready for planting



FIGURE 11.—A vine pruned at the end of the first year

PRUNING

PRINCIPLES CONSIDERED IN PRUNING

To prune intelligently, the age, size, and condition of the plant, the location, climate, soil, and other features of its environment, and the principles governing its life must be considered.

A statement of some of the more important of these life principles follows: The sap flows with greatest force to the outer extremities; the more upright a branch is, the more sap flows into it; the sap when abundant and active produces wood; the more abundant the flow of the sap, the larger and later the fruit; the ascending sap flows richer the farther it flows; checking the flow of the sap makes the plant bear earlier and produces more and richer fruit. The vine

usually bears its fruit on new shoots growing from the wood of the previous year. The time for pruning is in winter, when the vines are dormant. They should not be cut when frozen or while the sap is flowing rapidly. Summer pruning is practiced on the young growth to regulate the quantity of fruit and the shape of the plant.

OBJECTS OF PRUNING

Pruning usually has one or more of the following objects: Removal, renewal, promotion, or retardation of parts of the plants; curing of wounded or diseased plants; modification of shapes and habits of plants; increase or decrease in the size and quantity of the fruit; improvement in the quality of the fruit; making fruit ripen earlier or later; regular succession of fruit; facilitation of spraying, training, or cultivation of the vine and the gathering of the fruit.

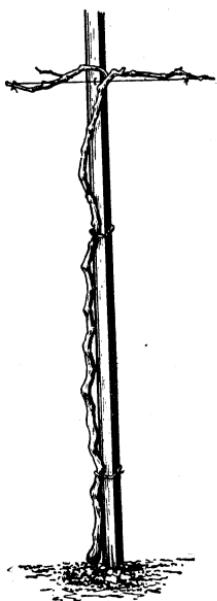


FIGURE 12.—A grapevine trained to a stake

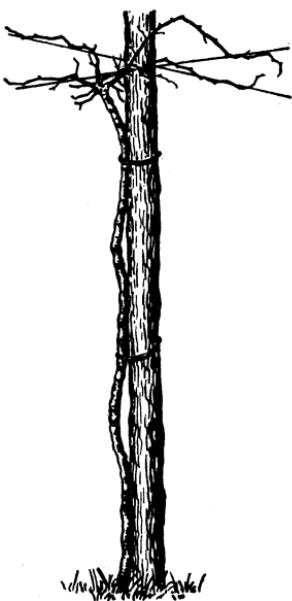


FIGURE 13.—A *rotundifolia* grapevine trained to a post

METHODS OF PRUNING

Different countries have different methods of pruning and training, and methods often differ in the several districts of the same country. The inherent peculiarities of the varieties themselves often require special methods to obtain the best results. No attempt will be made to describe methods other than those that appear most applicable and have proved most satisfactory for the grape species grown in various parts of the United States.

The objects of pruning are accomplished in various ways. For instance, the growth and health of a plant are promoted and the size of the fruit is increased: By removing all the diseased parts and suckers; by shortening extended shoots, side shoots, and laterals; by putting upright the part whose rapid growth is desired; and by removing the fruit buds or fruit. The plant is retarded in growth

and made to bear earlier and richer fruit by shortening the leading shoots and leaving the fruit-bearing wood and by bending down the branches and ring pruning them. The healing of wounded and diseased plants is promoted by removing the injured parts and dressing the wounds. The head of a plant is renewed by cutting off the branches above; the head is made to grow thicker by cutting back the outer branches and to grow thinner by amputating all canes on which there is too much growth.

There are many species of grapes, each having peculiarities and therefore responding most readily to the cultural methods to which it is best adapted. Therefore the pruning, training, and growing of vines become complicated operations in which comparatively few people become expert, and serious mistakes are often made.

FIRST PRUNING AFTER PLANTING

The first pruning after planting may be done at any time during the winter when the vines are dormant and not frozen. The extent of the pruning will depend on the growth that has been made. If the growth has been small, all the canes except the strongest should be removed, and this one cut back to two eyes. (Fig. 11.) If a strong growth has been made and there is one straight well-ripened cane, all other growth should be removed and this cane cut back to the height at which it is intended to head the vine. The cane should be tied securely and, as it is to become and remain the trunk or main body of the vine, should be kept as nearly erect and straight as possible. (Fig. 14.)

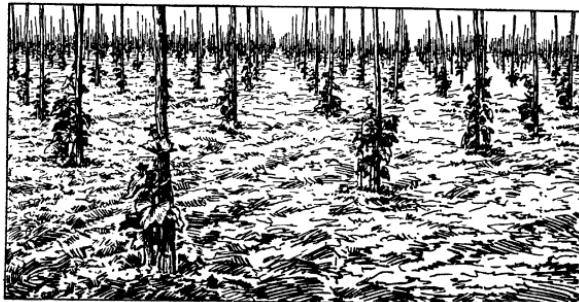


FIGURE 14.—Vines growing in a vineyard the first year, showing single shoots tied to stakes

SUMMER PRUNING

If the vine was cut back to two buds, only one should be allowed to grow. All other young shoots should be removed, preferably when quite young and not more than 3 or 4 inches long. This concentrates all the force and growth of the plant into the cane which is to become the trunk of the vine. The shoot left to grow must be kept carefully tied to the stake to cause it to grow erect and also to protect it from being broken by the wind or other agency. When a shoot has grown to a foot above the point at which it is to be headed, it should be topped slightly above where the head is to be. This will cause laterals to grow where they are desired. Only such shoots as are needed for shaping the vine for the following season should be allowed to grow. (Fig. 15.) All suckers should be promptly removed.

WINTER PRUNING

By the third year all vines should have erect, straight stems with two or more canes growing from the principal part. The

head or crown is to be formed from these canes and from them the growth of the vine is to be renewed from year to year.

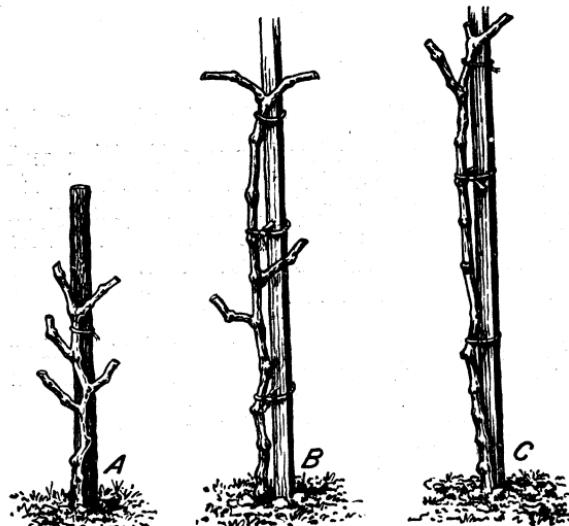


FIGURE 15.—Vines headed back for different systems of training: A, The spur and fan system; B, the 4-arm renewal system; C, the 2-arm renewal or umbrella, Munson and overhead system.

but making it bear to its full capacity. If this is done, the body of the plant gradually becomes stronger and its fruiting capacity increases correspondingly, no wasteful plant growth is allowed at the expense of fruitage, and the vines are easily kept clear of insects and fungous diseases. The manner of renewing the growth on the body of the vine so as to leave the body permanent is illustrated in Figures 9 and 16, which show the same vine before and after pruning.

In Figure 9 the 2-year-old arms, 1, 2, 3, and 4, which grew during the previous summer, were the only canes allowed to remain, when the vine was pruned in the winter. The canes shown grew from these and bore fruit the next summer.

The vine, when permitted to do so, bears its fruit on shoots from the last year's wood growth; therefore, the cardinal point underlying all correct pruning under any method of training, is first to grow and shape or adjust the main body or permanent part of the vine to the method of training desired. After this has been done the growth on this, the fruit-bearing part of the plant, should be so pruned that it will be renewed from year to year, never allowing the plant to overbear

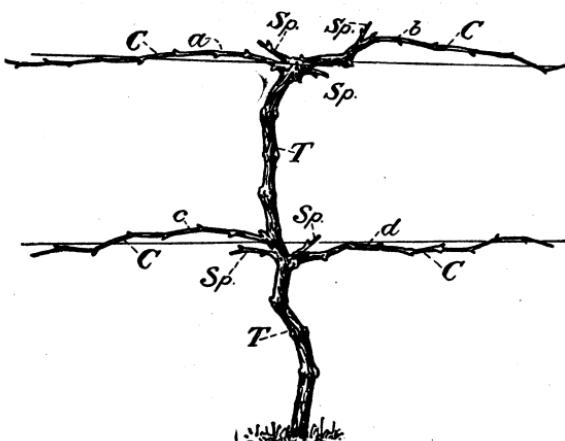


FIGURE 16.—A vine pruned according to the 4-cane renewal system: C, Canes, called shoots when green and canes when mature; Sp., spurs, canes cut back to one to four eyes; T, trunk, the stem or main body of the vine; a, b, c, d, arms succeeding those shown at their 2-year-old stage in Figure 9 at 1, 2, 3, 4

When pruned the following winter, as seen in Figure 16, only the canes *a*, *b*, *c*, and *d* were left, and these were tied to the wire in the same manner as the arms 1, 2, 3, and 4, of the season before. (Fig. 9.) The spurs shown (fig. 16, Sp.) are canes cut back to one to four eyes for the purpose of starting new canes to be left the following year. Ten cuts were required to prune the entire vine.



FIGURE 17.—A grape arbor

TRAINING AND TRAINING SYSTEMS

Around city homes where there is room for only a few vines, they are often trained on porches, fences, outbuildings, trees, etc. Where there is sufficient space an arbor like that shown in Figure 17 is a good and attractive support, making the vine furnish a shady bower or walk as well as fruit. In vineyard practice some growers use only a stake or post on which to train each vine. (Fig. 12.)

THE TRELLIS

A support very generally used consists of substantial posts of durable timber planted at regular intervals, the distance apart varying with the different grape varieties and the distances between the plants. (Fig. 18.) Sometimes two, but generally three, strands of No. 10 or No. 12 wire are fastened to the posts, the first, second, and third wires being 24, 40, and 56 inches, respectively, from the ground.

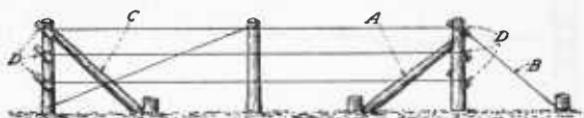


FIGURE 18.—Diagram of an ordinary trellis, showing the braces (A, B, C) and devices (D) used for tightening the wires

The end posts of the rows should be firmly braced. The two most common methods of bracing are shown in Figure 18, A and B. Another method often used is shown at C. Since wire contracts in cold and expands in warm weather, the trellis wire should not be stapled to the end posts, but should be fastened to them by some device like a simple reel, as shown at D in Figure 18. Some persons use a clamp pulley and a rope for tightening the wire and then wind the slack part two or three times around the end post to fasten it. Securing good, durable vineyard posts is steadily becoming more difficult and expensive, so that it appears to be only a very short time before substitute materials will have to take their place. Experiments show that some of the metal fence-post material on the market can advantageously be used in place of wood and that trellises entirely of metal may be less expensive and are much more durable than wooden ones not set in concrete.

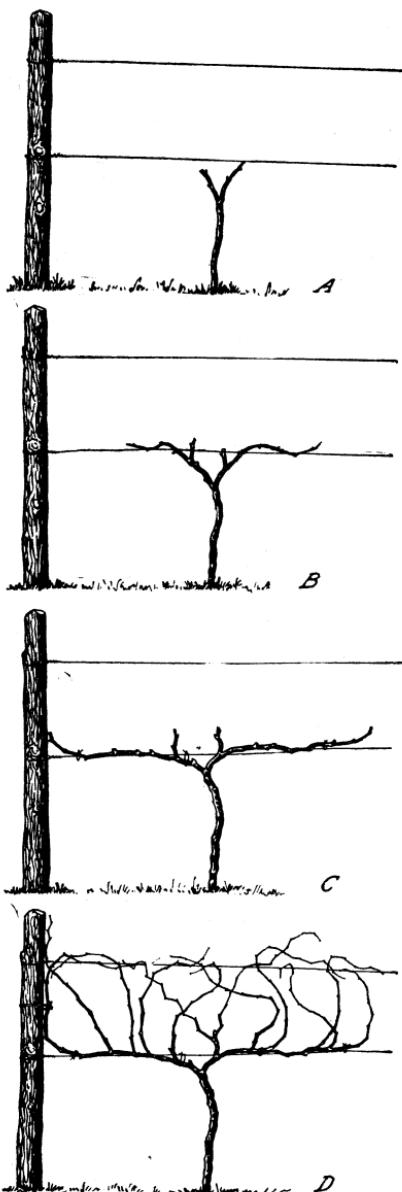


FIGURE 19.—A pruned and an unpruned vine at different ages, showing the method of pruning by the renewal system: A, Second year; B, third year; C, fourth year; D, an unpruned vine in its fourth year.

generally practiced in training trained by it can easily be laid down and covered in winter in the ex-

HIGH-RENEWAL OR UPRIGHT SYSTEM

In the high-renewal or upright system of training, all the season's growth is cut off each year except the head of the vine, which is cut back, leaving a cane and a spur on each side, and the canes are tied to the lower wire on the trellis. The length of the canes and the number of the eyes left on them will depend on the variety and size of the vine. The fruiting shoots growing from the canes are trained upright and fastened to the wire overhead. Figure 19, A, shows a vine pruned according to this system at the end of the second year and Figure 19, B, at the end of the third year. Figure 19, C and D, shows the same vine a year later, before and after pruning. This system is the one most American grape varieties. Vines

treme northern sections. A small amount of wood is left in pruning healthy vines, and a good quality of fruit is obtained.

HORIZONTAL-ARM SPUR SYSTEM

In the horizontal-arm spur system two horizontal arms, one on each side, are grown from the body of the vine at the lower wire of the trellis and tied to this wire. These arms remain, but the canes on them are cut back every year to spurs of two fruitful buds each. The fruit-bearing shoots growing from these are tied to the wires overhead, the number of spurs left depending on the variety and size of the vine. New spurs to replace those becoming weak or out of shape are grown from new shoots starting from the horizontal arm. In this system the vines are pruned and trained the same as for the high-renewal system, up to the end of the fourth year. Sometimes the horizontal arms are also renewed.

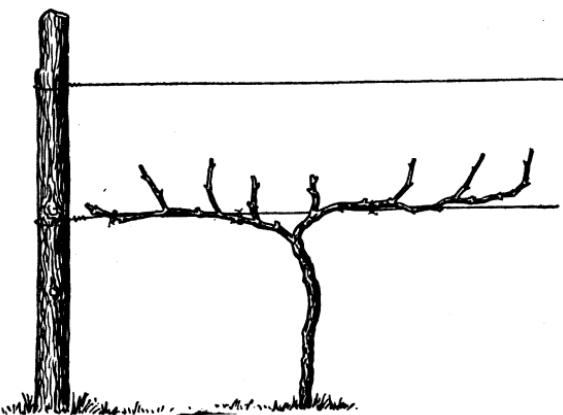


FIGURE 20.—A vine in its fourth year pruned according to the horizontal spur renewal system

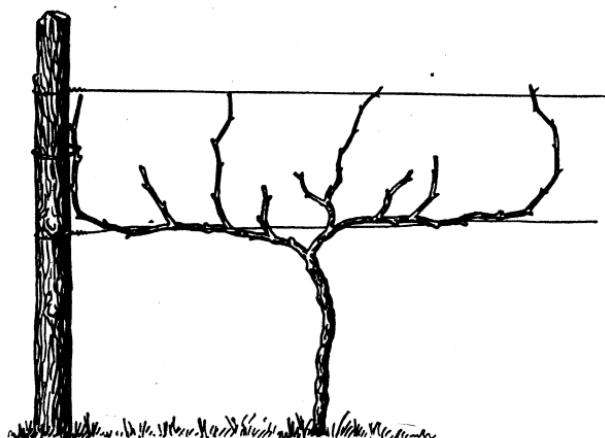


FIGURE 21.—A vine in its fourth year pruned according to the block system

otherwise it is not as good. More old wood is left and the pruning is more tedious and expensive than with the high-renewal system.

HORIZONTAL BLOCK SYSTEM

The horizontal block system combines some of the points of each of those preceding. Under it the vines are manipulated as under

Figure 19,D, represents an unpruned vine. Figure 20 represents the same vine pruned according to this system.

This system was at one time extensively practiced in the Chautauqua grape belt on Lake Erie. With it more fruit is obtained from some varieties than by the preceding method, which results in too much wood growth; otherwise it is not as good. More old wood is left and the pruning is more tedious and expensive than with the high-renewal system.

the preceding systems and pruned in the same way for the first four years, after which the unpruned vine is pruned as shown in Figure 21. As practiced in the same localities this system appears to be a combination of the high-renewal and the horizontal-arm spur systems.

FAN SYSTEM

In the fan system the vine growth, which is trained to an upright trellis, is annually renewed to within a short distance from the ground. The vines are cut back, usually to four canes and as many spurs each year; the canes are spread out and tied to the trellis, giving the vine the shape of a fan. Figure 22, A and C, shows an unpruned vine in the third and fourth years. Figure 22, B, shows the same vine pruned the fourth year under this system.

The advantages claimed by the advocates of this system are that most of the old wood is dispensed with each year, that the vines can be easily laid down and covered in winter when needful in the extreme northern sections, and that if after pruning the canes are tied and spread fan shaped on the trellis, as they should be, the

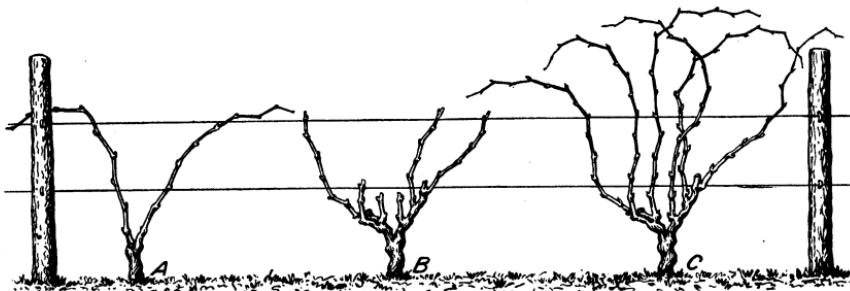


FIGURE 22.—A vine at different ages, showing the method of training by the fan system: A, An unpruned vine in its third year; B, a pruned vine in its fourth year; C, an unpruned vine in its fourth year

young upright-growing shoots fasten themselves by their tendrils and need practically no tying. This system has the disadvantage of bearing the fruit too low and is not now in use so generally as formerly.

HUDSON HORIZONTAL SYSTEM

The Hudson horizontal system, extensively practiced, as its name implies, along the Hudson River, uses an ordinary 2-wire trellis. A strong stake reaching to the top wire of the trellis is driven behind each vine. Four perpendicular slats which do not touch the ground are fastened to the trellis, two on each side of the vine and 12 to 15 inches apart. (Fig. 23.) Woven-wire fence could be substituted for the slats. The vine is annually renewed back of the trunk, which is about a foot high, and a single cane and spur are left at each pruning, the cane being long enough so that when tied it reaches to the top of the stake. About six bearing shoots left to grow on each side of this cane are fastened horizontally to the slats. The clusters hang free from the shoots. When the shoots become too long they should be summer pruned. From the spur left on the trunk the cane is grown erect and tied to the stake, to become the fruiting cane to be left the next year. Figure 23, A, shows a vine at the end of the third year

pruned according to this system. Figure 23, B and C, shows the same vine before and after pruning, a year later.

The advocates of this system claim for it a more uniform distribution of the young shoots and say that the fruit hangs well supported and protected.

FOUR-CANE RENEWAL SYSTEM

On the trunk of the vine at the lower wire of a 2-wire trellis, about 30 inches from the ground, two canes and two spurs of last year's growth are left and two more canes and spurs are left at the

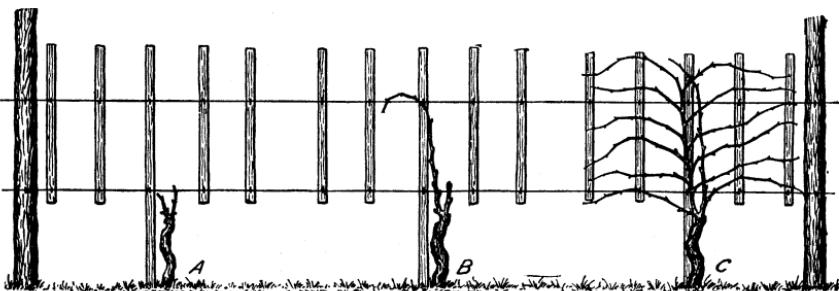


FIGURE 23.—A vine at different ages, showing the method of training by the Hudson horizontal system: A, a pruned vine in its third year; B, a pruned vine in its fourth year; C, an unpruned vine in its fourth year

top wire, about 56 inches from the ground. These canes, which are tied to the wire on each side of the vine, produce fruiting shoots which are allowed to hang down or droop, as seen in Figure 9. The same vine as it appears after pruning at the end of the fourth year when trained according to this 4-cane renewal system is shown in Figure 16. This system is said to be especially adapted to strong-growing varieties. Vines trained according to it are easily and quickly pruned and require only a limited amount of labor in the growing season. This system is largely used with such varieties as

Sultana, Sultanina (*Thompson Seedless*), and Emperor in the *vinifera* regions, and has been extensively used along the Hudson River and elsewhere in the American native-grape region.

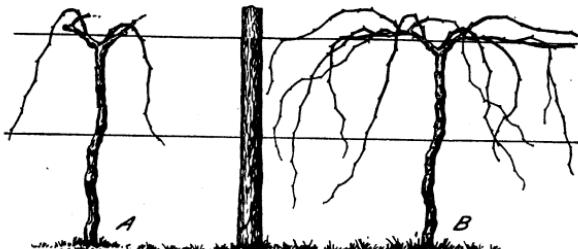


FIGURE 24.—A pruned vine (A) and an unpruned vine (B), showing the method of training by the umbrella or 2-cane renewal system

UMBRELLA OR 2-CANE RENEWAL SYSTEM

A system very generally used in training American vines is known as the umbrella or 2-cane renewal system and differs from the foregoing in that no canes or spurs are left at the lower wire, the trunk of the vine extending directly to the top wire, where the growth is annually cut back to two canes and two spurs, one on each side, which are fastened to the top wire. It is best to tie the trunk to both the upper and lower wires to prevent violent whipping of the

hanging shoots. Some growers dispense with the lower wire. Figure 24, A and B, shows a vine trained according to this system, before and after pruning, at the end of the fourth year.

This system is really an improvement on the 4-cane renewal system. The absence of the two lower canes insures a good upright trunk, and the renewal of the fruit-bearing wood to one head makes the vine more easily pruned, leaves less old wood, and results in cleaner and better-ventilated vines.

MUNSON SYSTEM

The Munson system derives its name from its originator, Prof. T. V. Munson, of Denison, Tex. As first practiced by him, it used two rows of light posts or stakes, the posts driven opposite each other, with their tops 18 to 20 inches apart. Wires were stretched along the tops of the posts in each row, with a third wire somewhat lower and midway between them, suspended by cross wires.

Munson afterwards used single posts with a wooden cross bar fastened across the top of each. The outer wires of the trellis are fastened to the outer ends of the crossbar, and the in-

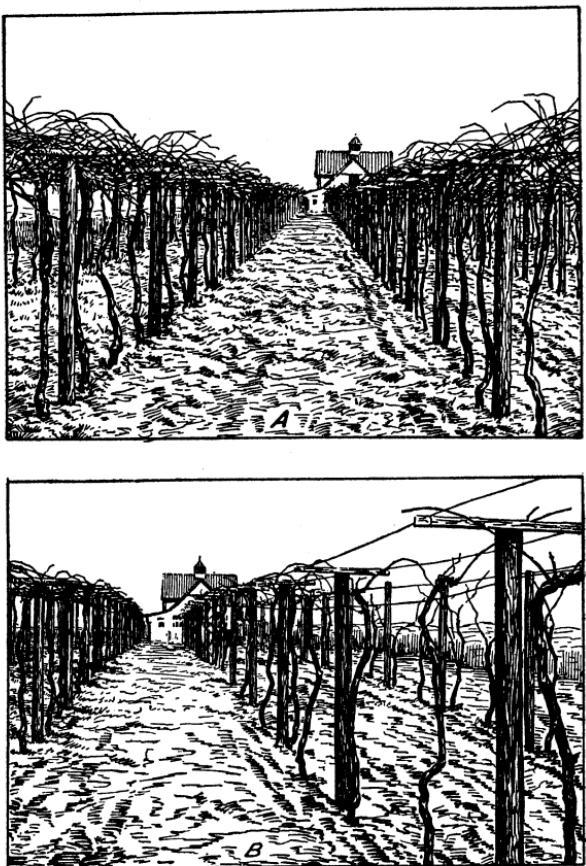


FIGURE 25.—Unpruned vines (A) and pruned vines (B), showing the method of training by the modified Munson system

ner wire is fastened to the post the desired distance lower down. The writer obtains essentially the same results in practice by using durable posts sufficiently heavy to allow pieces of 2 by 4 inch joint, 2 feet long, to be firmly spiked to them either at the side or on top, when they are sawed off at the right height. The outer wires are stretched on the cross joist, and the lower wire is either stapled against or run through the posts at the desired distance below, as shown in Figure 25, B. Four to four and a half feet above the ground is a good height for the lower wires for most varieties.

Under this system a single main trunk for each vine is grown and tied to the lower wire. In pruning this trunk two canes and two

spurs are left annually. The canes run to the right and to the left and are securely tied to the lower wire. The outer wires are for the sole purpose of supporting the growing shoots, which naturally develop from the canes and gradually droop toward the ground. Figure 25, A and B, shows the vines pruned and unpruned, trained after the modified Munson system. The writer considers this the best all-round system of training for localities where rains and storms occur during the growing season. It protects the fruit and places it in the most advantageous surroundings. It makes practicable and facilitates spraying for fungous diseases and insect pests and, after the original outlay for the trellis, lessens the cost of all operations and makes them easy and pleasant.

OVERHEAD CAYWOOD SYSTEM

In the overhead system, which has been used to some extent in New York, the vines are carried upon a canopy or overhead arbor 6 feet above the ground, consisting of three horizontal wires stretched at the same height. The center wire is fastened to posts which are placed at regular intervals, and the side wires are attached to 3-foot cross arms of wood fastened to the posts. The head of the vine is annually cut back to five canes and five spurs. The canes are fastened on the wires, two in one direction and three in the other, this division being alternated each year. Figure 26, A and B, shows vines pruned and unpruned, trained according to this system.

It has no advantages over the modified Munson system just described and to the writer appears inferior in every way.

CHITTENDEN SYSTEM

The Chittenden system as employed in Michigan is similar to the overhead system, but the trellis is lower, not exceeding 4 or 5 feet.

MULTIPLE CROSS-WIRE SYSTEM, OR OVERHEAD ARBOR

The multiple cross-wire system is used largely with the *rotundifolia* varieties of the South, which are usually planted 10 by 20, 15 by 15, or 20 by 20 feet apart. Under this method a substantial, durable post reaching 7 feet above the ground is set at each vine. Rows of well-braced posts, running parallel with and also at the ends of the rows of vines, are set along the boundaries of the vineyard.

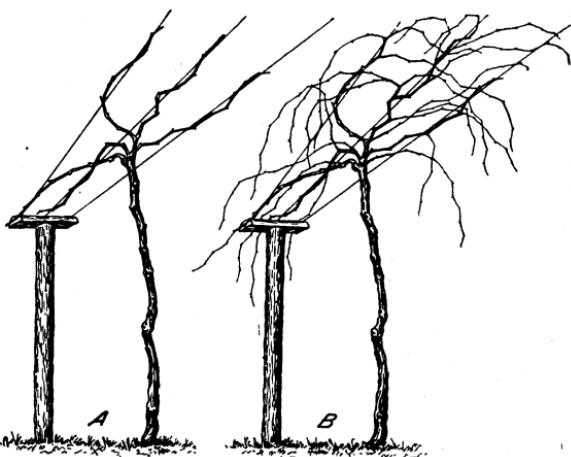


FIGURE 26.—A pruned vine (A) and an unpruned vine (B), showing the method of training by the overhead Caywood system

From the tops of these posts on the four sides of the vineyard a No. 10 galvanized wire is run along the tops of the inside posts down each row in both directions as a governor wire. No. 14 wires, 2 feet apart, are run parallel with the governor wires until in this manner the area has been entirely covered. It has been the general custom to cause a single trunk to grow erect from the ground alongside each inside post, keeping it tied thereto. When the vine has reached the top of the post it is pinched in or cut back so as to make it throw out shoots to grow and spread over the arbor. When this object is accomplished it is the general practice to do no more pruning, the growers asserting that the vines prune themselves. There is no reason, however, why the rotundifolia varieties should not be pruned and the fruit-bearing tops regularly renewed. Some

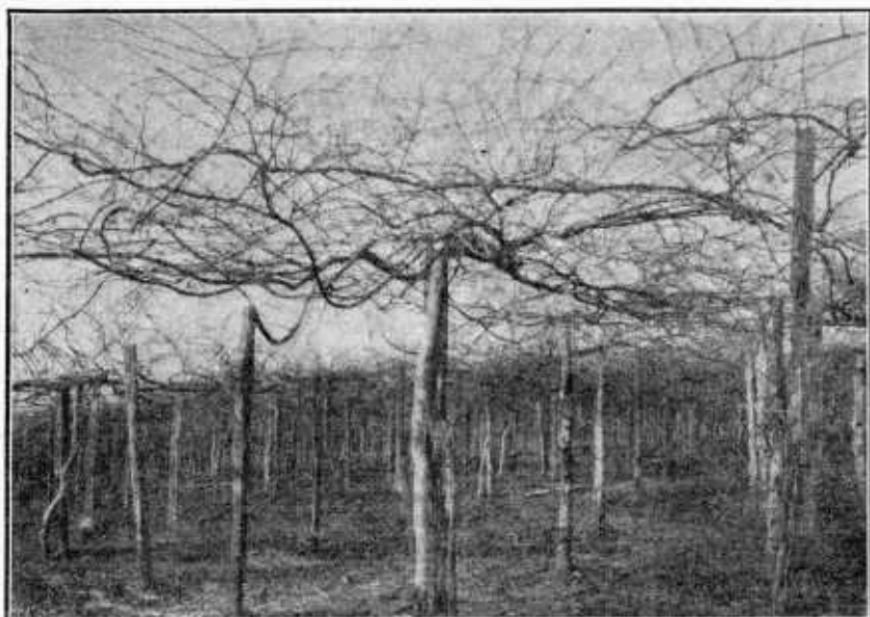


FIGURE 27.—Vines trained by the multiple cross-wire system or overhead arbor

growers construct arbors entirely of wood, using slats instead of wires. (Fig. 27:)

From experiments in methods of training rotundifolia varieties, which the United States Department of Agriculture has conducted under the direction of the writer for the purpose of improving the quality of the fruit, getting better and more regular fruiting results, counteracting black-rot injury, etc., there is reason to believe it will soon be necessary to advocate the growing of rotundifolia varieties on an upright trellis.

OVERHEAD TRELLIS OR PARRALES SYSTEM

The overhead trellis or parrales system is used in Almeria in training the Ohanez and other Almerian varieties of grapes. The trellis used is practically the same as the overhead wire trellis just

described as in use for the *rotundifolia* varieties. The Almerian vines are planted about 15 by 15 feet apart and trained with a straight stem to a height of about 7 feet. From the top of this stem fruiting canes varying from 10 to 15 in number and from 1 to 6 feet in length, according to the strength of the vine, are run out in all directions. These canes are annually renewed as near back to the main stem as possible with canes grown from spurs left for this purpose. (Fig. 28.) Since the growing of the *Ohanez* is becoming quite an industry in California, this system is receiving some attention in that State.

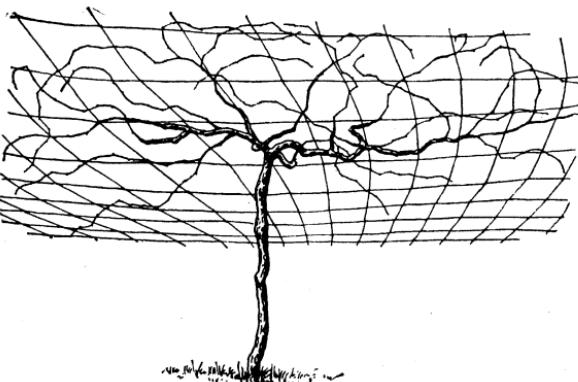


FIGURE 28.—Parrales, showing the system of training and the arrangement of the wires

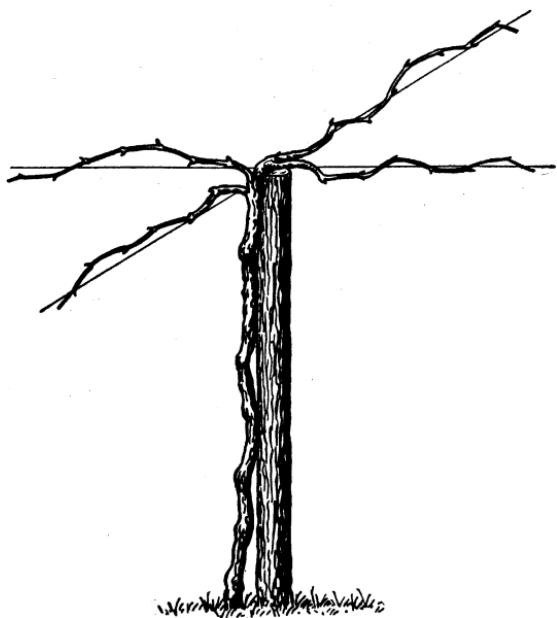


FIGURE 29.—A pruned vine, showing the cross-wire system of training

CROSS-WIRE SYSTEM

The single cross-wire system is used in the vicinity of Marlboro, N. Y. In this system posts are set 8 feet apart each way and made to project 6½ feet above the ground, a single wire running on top from post to post in both directions. A single trunk vine is trained up each post, four canes being run from it at the top of the post, and one cane fastened to each of the radiating wires. These canes are renewed each year. Figure 29 illustrates a vine pruned after this system.

SPUR, STOOL, OR SHORT PRUNING SYSTEM

The spur, stool, or short pruning system is extensively used in California with the stockier growing varieties of *vinifera*. It is the simplest and cheapest method of pruning and training vines.

This system permits the body of the vine to grow to the desired height and shoots to grow from only the two uppermost buds. The two resulting canes are cut back in the winter to spurs of two eyes each. The following year these spurs are allowed to produce growth, and the resulting canes are again cut back to spurs, all of which are allowed to remain if the vine is strong enough. (Fig. 15, A.) Thus, at the beginning of the fifth year the vine under ordinary conditions consists of a trunk from which spring four or five arms, on each of which a cane has been cut back to a spur, as shown in Figure 30. When the vine is pruned the following winter all or nearly all the outer canes that have grown from the spurs are entirely removed. The spurs of the last season are cut off just outside the inner canes, which are cut back to spurs, the pruning each winter after this being to promote a regular system of spur renewal.

As the vines become older and stronger and can stand more cropping, more spurs are left to increase the fruiting capacity of the plant. In course of time the arms of the respective spurs are renewed and entirely new arms and spurs are grown. The head of the vine should be kept well balanced and given a globular form, if possible. Some varieties on which the lower eyes are not sufficiently productive may be improved by increasing the length of the spurs and the number of eyes, leaving four or even five eyes to a spur according to the variety of vine.



FIGURE 30.—A pruned vine in its fifth year, showing the method of training by the spur, stool, or short system

and spurs needed from year to year, and as the plants grow older and stronger the fruiting capacity is increased by leaving more canes and spurs. Figure 15, A, shows a vine at the end of the second year; Figure 32, at the end of the third year; and Figure 31, at the end of the fifth year, pruned according to this system.

DISEASES AND INSECTS

The uses and manipulation of the vine for various purposes and the fungous and insect enemies of the grape, with methods of combating them, are discussed in another publication.¹

¹ QUAINTEANCE, A. L., and SHEAR, C. L., Insect and Fungous Enemies of the Grape. U. S. Dept. Agr. Farmers' Bul. 1220, 54 p., illus. 1926.

PRINCIPAL GRAPE REGIONS OF THE UNITED STATES

There are three distinct viticultural regions in the United States which are distinguished by the grape species grown in them, the *vinifera*, the *muscadine*, and the *American euvitis* or native grape.

The *vinifera* region, in which *vinifera* varieties are almost exclusively grown, is located almost entirely west of the Rocky Mountains, so much of it being in California that those not conversant with grape varieties erroneously call the *vinifera* varieties California grapes. With few exceptions, either the spur, stool, or short pruning system is used for the stockier growing varieties, and the long or

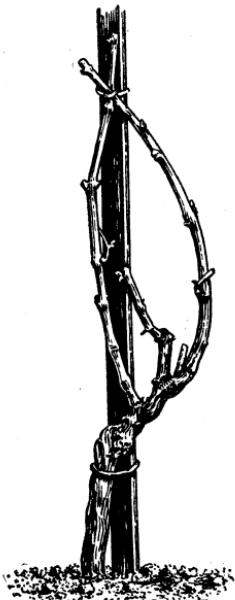


FIGURE 31.—A pruned vine in its fifth year, showing the method of training by the cane system

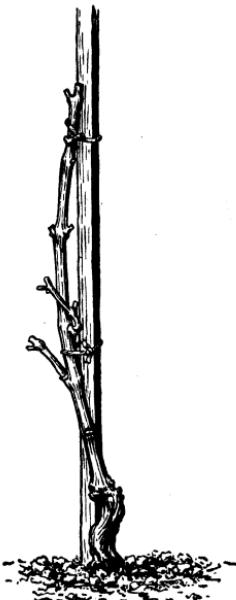


FIGURE 32.—A pruned vine in its third year, showing the method of training by the cane system

cane pruning system usually is used for the longer growing varieties, but either system is often modified to suit individual varieties. Thus the spurs are sometimes left longer in the spur system, and either spurs and canes left longer or spurs cut on the laterals in the cane system. Stakes only are most extensively used to give the vines the necessary support; this allows the vineyard to be cultivated crosswise as well as lengthwise.² Such strong-growing varieties as Emperor and Sultanina (erroneously called Thompson Seedless) are largely trained on trellises.

The more generally known *vinifera* varieties grown in this region are: Agadia, Alexandria, Alicante Bouschet, Aramon, Monukka, Burger, Cabernet Sauvignon, Carignane, Castiza, Chasselas de Fon-

² See *Grape, Raisin, and Wine Production in the United States, Yearbook, U. S. Dept. of Agriculture, for 1902.*

tainebleau, Emperor, Flame Tokay, Grand Noir, Green Hungarian, Grenache, Gros Guillaume, Malaga, Mataro, Mission, Mondeuse, Mourastel, Muscat Hamburg, Ohanez, Olivette Blanche, Olivette Noir, Palomino, Panariti, Pedro Ximines, Petit Syrah, Prune de Cazouls, Riesling, Sauvignon Vert, Semillon, Sultanina, Sultanina Rosea, Sylyaner, Valdepenas, Zeini, and Zinfandel.

The Muscadine region of the South Atlantic and Gulf States includes the entire southeastern coastal plain, extending from the Potomac to Florida, reaching well up into the Blue Ridge Mountains and along the Gulf coast to the Rio Grande River, spreading to the north along the Mississippi River into the great central plains to southeastern Missouri and the Tennessee River. In this region improved varieties of the rotundifolia and munsoniana species are grown for various purposes, the better known varieties of these being the Eden, Flowers, James, Mish, Scuppernong, and Thomas. The multiple cross-wire system or overhead arbor is almost exclusively used. As previously mentioned, these arbors are very similar to the overhead trellis or parrales system used in Spain with the Almerian varieties commonly seen in our markets packed in cork dust and called "Malaga" grapes.

In the American euvitis or native-grape region improved varieties of the more northern native-grape species and hybrids of them and the vinifera species are grown. This region comprises all that part of the United States which lies east of the Rocky Mountains. Of late years a few plantings have also been made in parts of Oregon and Washington, but the industry is most extensive in the States west of the Hudson River and north of the Ohio River that border on the Great Lakes and in the more centrally located States of the Mississippi Valley. In this district the high-renewal, horizontal-arm spur, horizontal block, fan, Hudson horizontal, 4-cane renewal, umbrella or 2-cane renewal, Munson, overhead Caywood, and Chittenden systems are used, the localities in which they originated or are most common being stated in the description of the various systems. The varieties most extensively grown are the following: Agawam, America, Arkansas, Barry, Beacon, Brighton, Brilliant, Caco, Campbell, Captivator, Carman, Catawba, Champion, Clinton, Concord, Cynthiana, Daisy, Delaware, Diamond, Diana, Dutchess, Eaton, Elvicand, Elvira, Empire State, Fern Munson, Gold Coin, Gaertner, Goethe, Goff, Headlight, Herbemont, Herbert, Hernito, Husmann, Iona, Isabella, Ives, Janesville, Jefferson, Lady, Laussel, Lenoir, Lindley, Lutie, Martha, Massasoit, Merrimac, Missouri Riesling, Moore, Nectar, Niagara, Noah, Norton, Peabody, Perkins, Pocklington, Prentiss, Rebecca, Rommel, R. W. Munson, Salem, Triumph, Ulster, Vergennes, Victor, Wilder, Winchell, Wetumka, Woodruff Red, Worden, and Wyoming.

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